A7B

PROPERTY OF
HARRIS TECHNICAL
SERVICES CORPORATION
NORFOLK, VA

AILTECH

707 SPECTRUM ANALYZER

RAPID PERFORMANCE CHECK
AND
ADDENDUM FOR 004 OPTION

AILTECH

SPECIFICATIONS AILTECH 707

FREQUENCY SPECIFICATIONS

TUNING RANGE

With internal mixer 1 MHz to 12.4 GHz (useable to 10 kHz).
With external mixer 12.4 to 40 GHz.

SCAN WIDTH

Per cm: 14 calibrated scan widths from 1 kHz/cm to 700 MHz/cm.
Surveillance mode: continuous 10 GHz display from 2 to 12 GHz.
(IF bandwidth and sweep rate fixed at 1 MHz and 50 Hz respectively.)
Full Scan: Complete display of selected band. Inverted marker positioned by tuning control identifies the frequency that becomes the center frequency for scan width/cm and Time Domain mode. Frequency automatically indicated on digital readout.
Time Domain: Analyzer becomes fixed tuned (zero scan width) receiver. Automatically activated when fast sweep times are selected.

FREQUENCY ACCURACY

Digital Readout (5 digits):
± 0.2% from 2 to 12.4 GHz
± 8 MHz from 1 to 2 GHz
± 6 MHz from 1 MHz to 1 GHz
(Typically, ± 2 MHz from 1 MHz to 2 GHz and ± 0.1% from 2 to 12.4 GHz)
Digital Readout Resolution: ± 2 MHz
Scan Accuracy: Frequency error between two points on the display is less than ± 5% of the indicated separation.
Residual FM:
< 200 Hz p-p when phase locked 1 MHz to 12.4 GHz
< 10 kHz p-p non-phase locked 1 MHz to 4 GHz
< 30 kHz p-p non-phase locked 4 to 12.4 GHz
Noise Sidebands:
For fundamental mixing with 1 kHz IF bandwidth and 500 Hz video filter.

Level Below CW signal	Separation from signal
> 70 dB	30 kHz
> 80 dB	90 kHz
> 90 dB	300 kHz
> 100 dB	1 MHz

RESOLUTION

BANDWIDTH RANGES: IF bandwidths of 1, 10, and 100 kHz and 1 MHz may be manually selected. In Auto position, proper IF bandwidth is automatically selected as scan width and scan time are varied.
SELECTIVITY: 60 dB to 3 dB ratio of all filters is less than 5 to 1.
Off resonance rejection for all filters is greater than 100 dB.
VIDEO: Bandwidths of 500 Hz and 1 MHz may be manually selected. In Auto position, proper video bandwidth is automatically selected as scan width and scan time are varied.
BANDWITH ACCURACY:
1 kHz: typically 1.3 kHz ± 20%
10 kHz: ± 10%
100 kHz: ± 10%
1 MHz: typically 1.5 MHz ± 20%

FREQUENCY DRIFT

LONG TERM DRIFT: Typically, ± 1 KHz/10 min., stabilized after 1 hour warm-up.
STABILIZATION RANGE: First LO is automatically stabilized to internal crystal reference for scan widths of 300 kHz/cm and less.

AMPLITUDE SPECIFICATIONS

FULL SCREEN DISPLAY RANGE:
Logarithmic range: 100, 50 and 20 dB
Linear range: 0 to 10 cm
SENSITIVITY: Based on average noise level, specified for a 1 kHz IF bandwidth and 500 Hz video bandwidth.

RF Range (GHz)	Average Noise Level (Max.)
.001 — 2.0	—100 dBm
.001 — 2.0 (option 001)	—125 dBm
1.8 — 4.0	—110 dBm
3.3 — 8.3	—105 dBm
5.4 — 12.4	—100 dBm

(AMPLITUDE SPECIFICATIONS CONTINUED)

RESIDUAL RESPONSES: Referred to signal level at RF input <—90 dBm.

FREQUENCY RESPONSE:

RF Range (GHz)	Response (Max.)
.001 — 1.8	± 1.5 dB
1.8 — 4.0	± 2.0 dB
4.0 — 8.3	± 2.5 dB
8.3 — 12.4	± 3.0 dB
2 — 12	± 4.0 dB

RELATIVE GAIN VARIATION BETWEEN RF RANGES: ± 0.5 dB max.

IF GAIN VARIATION WITH DIFFERENT BANDWIDTH SETTINGS: ± 1.0 dB max.

RF ATTENUATOR: 0 to 60 dB in 10 dB steps. Frequency response typically ± 0.5 dB from 1 MHz to 12.4 GHz.

IF ATTENUATOR: 0 to 110 dB in 1 dB steps. Attenuator accuracy ± 0.25 dB per 10 dB steps but not more than ± 1 dB over full range.

LOG DISPLAY ACCURACY: ± 0.2 dB/dB but not more than ± 2 dB over the full 100 dB range.

MAXIMUM INPUT POWER: 2 watts (+33 dBm) with 20 dB or more RF attenuation. 0.1 watts (+20 dBm) with 0 dB attenuation.

DYNAMIC RANGE
(Ratio of maximum input signal to internally generated spurious responses):

Typically 80 dB.

SPURIOUS RESPONSE DUE TO SECOND HARMONIC DISTORTION:

1 MHz to 1 GHz: 70 dB down for —30 dBm inputs

1 GHz to 12.4 GHz: 120 dB down for 0 dBm inputs

SPURIOUS DUE TO THIRD ORDER INTERMODULATION DISTORTION:

1 MHz to 2 GHz: 80 dB down for —20 dBm input signals separated by greater than 200 kHz.

2 GHz to 12.4 GHz: 120 dB down for 0 dBm input signals separated by greater than 100 MHz. 80 dB down for —25 dBm inputs separated by greater than 200 kHz.

IMAGE RESPONSE:

1 MHz to 2 GHz: nonexistent

2 GHz to 4 GHz: (454 MHz lower in frequency) 70 dB down for 0 dBm inputs.

4 GHz to 12.4 GHz: (454 MHz lower in frequency) 60 dB down for 0 dBm inputs.

LOCAL OSCILLATOR RE-RADIATION (0 dB INPUT ATTENUATOR):

Typically: —60 dBm from 1 MHz to 2 GHz and —75 dBm from 2 to 12.4 GHz.

GENERAL CHARACTERISTICS

TEMPERATURE RANGE — OPERATING: 0° to 55° C; Storage: —40° to +75° C.

EMI: Conducted and radiated energy is within requirements of MIL-STD-461 and MIL-I-6181D.

POWER REQUIREMENTS: 115 or 230 volts ± 10%, 50 to 60 Hz, less than 220 watts.

DIMENSIONS: 12½" high (including height of feet) x 16¾" wide x 20" deep (317 x 425 x 508 mm)

WEIGHT: 83 pounds net (37.7 kg)

AILTECH 707 Options

■ INCREASED SENSITIVITY

High Sensitivity Option —001; an amplifier with 20 dB of gain is added at the first IF frequency, reducing the noise figure of the analyzer over the full 1 MHz to 2 GHz range to 14 dB. This permits a sensitivity with the 1 kHz bandwidth of better than —125 dBm.

■ RECEIVER OPTIONS

Wide Bandwidth IF Option —002; to provide a wider bandwidth for analysis and receiver work, the 227 MHz IF signal is brought out with a 20 MHz bandwidth. Conversion Loss is typically 15 dB for fundamental mixing and the output is fixed tuned when the time domain mode is selected or the analyzer operated at less than 1 MHz/cm scan width.

LO Output Option —003; the first oscillator tuning from 1.7 to 4.3 GHz is made available for use as a sweeping signal or to permit highly accurate frequency measurements to be made. Level is typically + 7 dBm ± 1 dB.

■ FREQUENCY COVERAGE TO 22 GHz

Increased Frequency Option —004; a mixer operating with a 10 GHz crystal-controlled oscillator downconverts 12 to 22 GHz to the analyzer's 2 to 12 GHz bands. An internal high pass filter provides preselection, which eliminates responses from all low frequency signals. Sensitivity with a 1 kHz IF bandwidth and 500 Hz video filter is as follows:

Frequency	Average Noise Level
12 to 14 GHz	—100 dBm
14 to 18 GHz	—90 dBm
18 to 22 GHz	—85 dBm

AILTECH
A CUTLER-HAMMER COMPANY

Reply To: EAST COAST OPERATION • 815 BROADHOLLOW ROAD • FARMINGDALE, NEW YORK 11735 • TWX: 510-224-6558 • TELEPHONE: (516) 595-6471
(Formerly AIL/Microwave Instruments Division)

March 20, 1975

PRD Electronics
6801 Jericho Turnpike
Syosset, New York 11791

Attention: Mr. T. Farfan

Gentlemen:

AILTECH has been compelled to make substitutions for several components in our Spectrum Analyzers because of vendor supply problems. As a result we have experienced a change in our long term drift performance. Our Engineering Department is evaluating the problem towards the goal of improvement on future production units. However, our current specification is typically ± 2 KHz/10 min. after a three hour warm-up.

This new specification defines a performance that is approximately the same as that of other comparable analyzers. We trust that you will not be inconvenienced by the change.

Very truly yours,

AILTECH,
a Cutler-Hammer Company

Gerry Petrelli HK

Gerry Petrelli
Regional Manager

GP:HK

CC: Scientific Devices/East

Changed, 3/28/75 as indicated (±5KHz)

WEST COAST OPERATION • 19535 EAST WALNUT DRIVE • CITY OF INDUSTRY, CA. 91748 • TWX: 910-584-1811 • TELEPHONE: (213) 965-4911
(Formerly Microdot Instrumentation Division)

T. Fafan

Received 4/2/75
J. F.

HARRIS COMMUNICATIONS AND INFORMATION HANDLING

PRD Electronics

TO	FROM	DATE
L. Bernstein/T. Farfan	H. Podobinski	1 April 1975 170:109:75

cc: O. Eichna
H. Busching

SUBJECT: AIL-Tech 707-004

Long Term Frequency drift of ±5 KHz/10 minutes is acceptable.

The typical specification of ±1 KHz/10 minutes should be waived.

H. Podobinski

HP:bb

RAPID PERFORMANCE CHECK

Equipment needed:

1. 100 MHz Comb Generator

2. Signal Generators for 3.0 GHz, 5.8 GHz and 8.9 GHz or absorption type frequency meters for same frequencies.

Procedure:

1. Turn unit on and allow 20 minutes for warm-up. Observe that the rear panel fan is operational and that the LED readout on the front panel is illuminated.

2. Observe that the left edge of the noise band starts at the left edge of the graticule; ie, coincident with the first graticule line.

3. Set the IF Attenuator to 100 dB and the IF Bandwidth to the 1 kHz Filter. The trace should be a narrow line 2 mm below the 100 dB mark. There are two additional small marks etched on the graticule for this alignment.

4. Return the IF Attenuator to 10 dB and the IF Bandwidth to Auto. The noise should return to approximately the 80 dB line.

5. Set the controls as follows:

RF Range	.001 - 2.0 GHz (Band 1)
RF Attenuator	20 dB
IF Attenuator	10 dB
Scan Width	200 MHz/cm
Bandwidth	Auto
Amplitude Range	10 dB/cm
Scan Mode	Auto
Baseline (center knob)	Max CCW
Tuning	Zero beat on left most graticule

Full Range (RF range center knob)	Max CCW OFF
Signal Center	Centered

6. Connect the Comb Generator to the type N input connector. Observe that 20 comb lines appear on screen.

7. Reset the Scan Width switch to 100 MHz/cm. Adjust the tuning control until the first comb line falls on the first graticule line. Observe that each following comb line also falls on a graticule line.

8. Locate the 1000 MHz comb line by counting 10 lines up from the zero heat. Adjust the tuning control to read 1000 (±6 MHz) and note that the comb line falls in the center of the screen. (Because of hysteresis in the YIG preselector it is sometimes necessary to rotate the Scan Width switch fully clockwise and then bolt to 100 MHz/cm before making this test).

9. Turn RF Range Switch to 1.8 to 4.0 GHz. Digital Readout should indicate 3000 MHz (± 0.2%). 3000 MHz comb line should fall in center of screen and adjacent lines on graticule lines. Locate 3000 MHz line using signal generator or frequency meter.

10. Set RF Range Switch to 3.3 - 8.3 GHz. Repeat step 6 using 5800 MHz frequency.

11. Set RF Range Switch to 5.4 - 12.4 GHz. Repeat step 6 using 8900 MHz.

12. Set the RF Range Switch to 2 - 12 GHz. Observe that the noise baseline has three levels, differing about 6 dB from each other. These variations are due to gain compensation as a result of the different conversion losses encountered in harmonic mixing. Also, observe that the comb lines gradually decrease in amplitude as the frequency increases.

    Overlap occurs at each crossover point to prevent loss of signal. In this mode most of the front panel controls are deactivated and the display is operated in fixed time with the 1 MHz IF bandwidth automatically selected. The digital readout should indicate 7000 MHz.

13. Return the RF Range Switch to the 1.8 to 4.0 GHz band. Adjust the tuning control, if necessary, until the 3000 MHz line is centered. Rotate the Scan Width switch CCW into the 300 kHz/cm position. The analyzer is now in phase lock. Rotating the tuning knob should move the signal on screen but not the digital readout. Continue rotating the Scan Width switch CCW until the 1 kHz/cm position is reached. Slight adjustments of the tuning knob may be required to keep the signal centered. The frequency instability should be less than 200 Hz. *

14. Return the Scan Width switch to 300 kHz/cm. Depress the Signal Center knob and rotate CW and CCW. Note that the signal will jump to another lock 1 MHz on either side.

15. Observe that the IF Bandwidths are automatically changed as follows:

Scan Width	Scan Time	IF Bandwidth
10 MHz/cm and above	3 ms/cm	1 MHz
3, 1 MHz and 300 kHz	"	100 kHz
100 and 30 kHz	"	10 kHz
10 kHz and below	"	1 kHz

Override the Auto position to verify filters.

16. Return IF Bandwidth to Auto and Scan Width to 10 MHz/cm. Bring signal level to 50 dB line using IF Attenuator (requires approximately 30 dB). Rotate Amplitude Range to 5 dB/cm and note that signal reaches top of screen.

17. Add another 30 dB of IF Attenuator and switch Amplitude Range to 2 dB/cm. Signal should fill screen.

18. Rotate Amplitude Range to Lin position - Adjust IF Attenuator to set signal at 70 dB line. Remove 10 dB from IF Attenuator and signal should almost reach top of screen (approximately 5 dB point).

19. Return Amplitude Range to 10 dB/cm and IF Attenuator to 10 dB. Verify that the intensity control adjusts the CRT intensity.

* SEE WAIVER AND SPEC. CHANGE

20. Rotate the Baseline knob CW until the noise baseband disappears. Rotate the concentric Contract knob CCW observing that the intensity of the clipped area can be controlled. Return all controls to their normal settings.

ADDENDUM TO 707 HANDBOOK

FOR

004 OPTION

TABLE OF CONTENTS

			Page
1.0		Option Description	1
	1.1	General	1
2.0		Option Specification	2
	2.1	Frequency Specifications	2
	2.2	Amplitude Specifications	2
	2.3	General Specifications	3
3.0		Theory of Operation	4
	3.1	Discussion	4
	3.2	Block Diagram	6
4.0		Operating Instructions	7
	4.1	General	7
5.0		Troubleshooting	8
	5.1	General	8
6.0		Parts	9

1.0 Option Description

1.1 General

Option 004 extends the frequency range of the 707 Spectrum Analyzer from 12 GHz to 22 GHz.

It is accomplished by the addition of a downconverter internally provided as an integral part of the analyzer.

Normal spurious responses resulting from frequency conversions are minimized by the preselection feature of the 707 Analyzer.

Selection of the high frequency range is controlled by a front panel switch.

Performance of the analyzer in its normal mode is the same as that of a standard 707.

2.0 Option Specifications

2.1 Frequency Specifications

2.1.1 RF Ranges

11.8 - 14.0 GHz

13.3 - 18.3 GHz

15.4 - 22.4 GHz

12 - 22 GHz

2.1.2 Residual FM

less than 300 Hz peak to peak when phase locked.

2.1.3 Frequency Accuracy

Digital Readout (5 digits)

$\pm$ 0.1% from 11.8 to 22.4 GHz

2.2 Amplitude Specification

2.2.1 Sensitivity

Based on average noise level, specified for 1 KHZ IF BW and 500 Hz Video BW.

RF Range (GHz)	Average Noise Level (Typ.)
11.8 - 14.0	-100 dBm
13.3 - 18.3	-90 dBm
15.4 - 22.4	-80 dBm

2.2.2 Frequency Response

RF Range (GHz)	Response (Typ.)
11.8 - 14.0	± 3 dB
14.0 - 18.3	± 4 dB
15.4 - 22.4	± 5 dB

2.2.3 L.O. Reradation (0 dB Input Attenuation)

Fundamental (10 GHz)	-80 dBm
Harmonics (20, 30 GHz)	-40 dBm

3.1 General Characteristics

3.1.1	Temperature Range	Operating 0^{o} to $55^{o}C$
		Storage -40^{o} to $+75^{o}C$

3.0 Theory of Operation

3.1 (Refer to Figure 1, Section 3.2)

Placing the Extended Range Switch, S 11, on the front panel, in the 12 - 22 GHz position causes the RF switches to make contact in position #1 adding an additional stage of downconversion. All incoming frequencies above 12 GHz pass through the filter and are mixed with a 10.0 GHz crystal oscillator signal. The resulting difference signal is then processed by the 707 in the normal manner.

For example, a 14.7 GHz signal is downconverted to 4.7 GHz and then routed to the normal analyzer circuitry. The digital frequency display is adjusted to read the correct input frequency by adding a "1" to the tens digit in this mode.

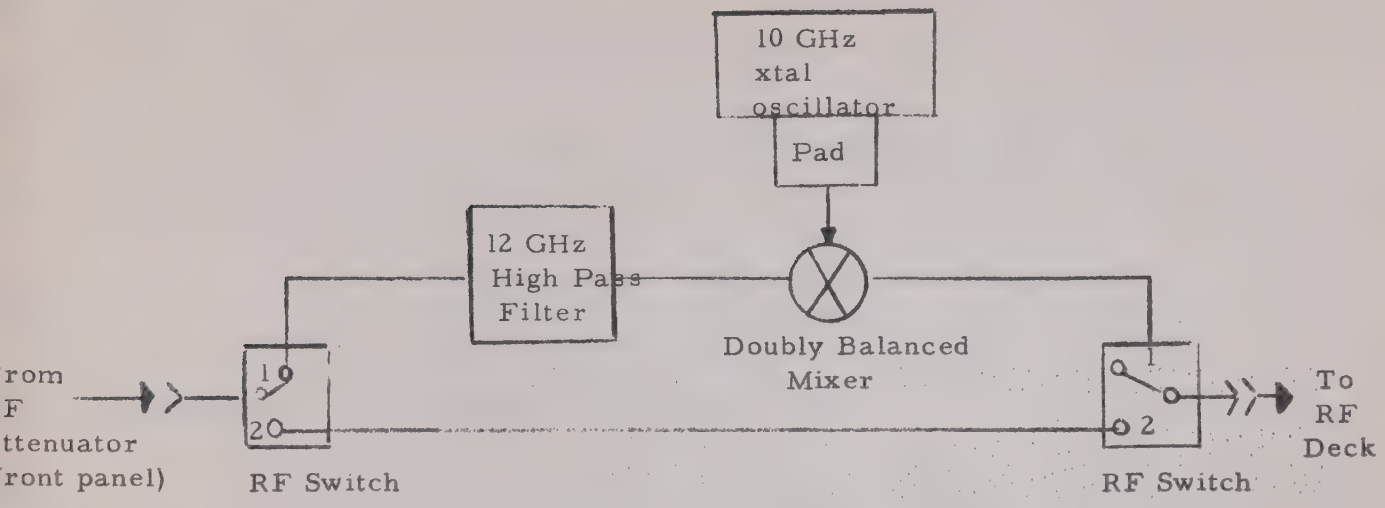
The 12 GHz high pass filter excludes all signals below 12 GHz which could produce spurious responses. It also reduces LO reradation of the 10 GHz oscillator to typically -80 dBm.

Even though a doubly balanced mixer is used in this option to further reduce spurs some multiple responses are still possible. These occur when an input signal mixes with harmonics of the 10 GHz oscillator generated in the mixer. As an example, a 13 GHz signal would be down-converted to 3 GHz and correctly displayed when the analyzer is tuned to 13 GHz. It would also mix with the second harmonic of the LO (20 GHz)

generating an IF of 7 GHz and be displayed on screen at 17 GHz.

The number of false responses are minimized by the high frequency of the oscillator and are always smaller in amplitude than the correct signal because of harmonic mixing. In addition, since the fundamental oscillator is lower in frequency than the input signal, all displayed multiple responses will tune in an opposite direction from the input.

A signal is always observable at 20 GHz. It is analogous to the zero beat and results from the 10 GHz oscillator feeding through the mixer. It is an excellent frequency marker and provides a test signal for high band performance.



NOTE: These components are inserted between the 60 dB Attenuator (230212) and the RF Switch (230193A) shown in Figure 3-11, page 3-27 of the 707 Service Manual.

FIGURE 1

4.0 Operating Instructions

4.1 General

The ease of operation of the 707 Spectrum Analyzer is retained for the 004 option.

4.1.1 For normal operation the Extended Range Switch, S 11, on the front panel should be in the 0-12 GHz position. No other special operational steps are required.

4.1.2 For high frequency operation, switch S 11 must be in the 12 - 22 GHz position. To eliminate misinterpretation of the displayed signals the following two response characteristics should be kept in mind:

A. A 20 GHz marker signal is always displayed.

B. A multiple response is generated due to the second harmonic of the L. O. produced in the mixer. This response will always be lower than the real response (typically by more than 10 dB) and obeys the following mathematical relationship.

Real response Input - 10 GHz

Multiple response 20 GHz - Input

Note that if the input frequency is increased the real response will increase while the multiple response decreases.

5.1 General

Proper operation of the 004 option requires the following:

A. The two RF Switches operate alternately; i.e., when one is energized the other is deenergized. Switch S11 applies 24 VDC to the coil of the switch as the operating voltages.

B. The 10 GHz oscillator must have a minimum power output of 10 mW.

C. Switch S11 applies 4.2 ± 0.5 VDC to Pin U of J3 in the 0-12 GHz position, and 0 VDC in the 12-22 GHz position, for proper operation of the digital readout.

D. Low sensitivity is generally caused by a failing mixer or an insecure connection in the RF chain.

E. If spurious responses are noted, check the Spectral purity of the 10 GHz oscillator. Some units require a 10 GHz bandpass filter between the oscillator and mixer to reject spurs at approximately 13.2 GHz.

Spectral purity can be checked by disconnecting the mixer and observing the output from the 3 dB pad, on the bandpass filter if provided, on the 707. All spurs at this point should be 65 dB below the 10 GHz signal.

6.0 Parts

Item	Manufacturer	Part No.
Oscillator, 10 GHz	AILTECH	230913
Filter, Bandpass (if required)	AILTECH	231133
Filter, High Pass	AILTECH	298764
Switch, RF	AILTECH	231079
Mixer	AERTECH	MX18000